A.D. 1876, 28*th* SEPTEMBER. N° 3782.

Appliances for Generating and Applying Electricity.

LETTERS PATENT to Isac Louis Pulvermacher, of 194, Regent Street, in the County of Middlesex, Electrical Engineer, for the Invention of "IMPROVEMENTS IN APPARATUS OR APPLIANCES CONNECTED WITH GENERATING, CONDUCTING, MEASURING, OR TESTING AND APPLYING ELECTRICITY."

Sealed the 23rd March 1877, and dated the 28th September 1876.

PROVISIONAL SPECIFICATION left by the said Isac Louis Pulvermacher at the Office of the Commissioners of Patents on the 28th September 1876.

ISAC LOUIS PULVERMACHER, of 194, Regent Street, in the County of Middlesex, Electrical Engineer. "IMPROVEMENTS IN APPARATUS OR APPLIANCES CONNECTED WITH GENERATING, CONDUCTING, MEASURING, OR TESTING AND APPLYING ELECTRICITY."

This Invention relates to improvements in apparatus or appliances connected with generating, conducting, measuring, or testing and applying electricity, and consists in employing carbon vessels of a certain porosity and of various shapes, for instance, flat or cylindrical. In the hollow of these vessels I place a bar or hollow cylinder of zinc in such a manner as to prevent a contact with the carbon vessel. The space between the zinc and the carbon vessel is filled with pulverized salt of ammonia or a substitution thereof of any other salt of an analogous action, which when slightly moistened with water, so as not to dissolve, excites the galvanic element thus formed. When the circle of such an element is closed an electric current of a constant action is produced by the atmospheric oxygen absorbed by the porous carbon vessel. The oxygen in presence of the salt of ammonia depolarises the carbon, and thus secures a constant current. Such elements I use for making stationary as well as chain batteries, and I establish voltaic connections among such elements accordingly.

According to my second improvement I form hollow vessels composed in part of zinc and part of carbon, united and fixed together so as not to come in direct conductible contact, and to furnish the hollow space for the reception of the salts, serving to excite and maintain an electric current with constancy.

According to the third improvement I substitute platinized silver coated with platinum black for the carbon parts referred to in the second portion of the foregoing.

My fourth improvement consists in making a resistance coil for measuring and testing the strength of an electric current from bands made of thin German silver

wire spun by the process and in the manner as used by me for making my other bands.

My fifth improvement consists of a voltameter or electrolytic current measurer combined with a variable resistance changer and measurer and graduator of the strengths of currents.

Another part of my Invention consists in constructing cylinders of compressed carbon (moulded) with both ends open, the carbon in some cases having when in a state of paste a proportionate quantity of peroxide of manganese, of chloride of silver, or of chloride of platinum in powder admixed with it. The cylinders have each a groove formed in the inside near one end for the reception and fixation by pressure of a gutta percha wad or bottom piece to make the cylinder water-tight. The centre of this wad is hollow, and a metal bolt or headed pin is passed through it from the inside that the head may rest thereon and that the stem may project from the outside. I employ a cap with raised edge to fit the exterior of the cylinder to which it is fixed by pressure or other convenient means to retain it in contact. The cap forms part of a link by which the neighbouring element is connected as a chain and as hereafter described.

The carbon cylinder above the gutta percha bottom carries a kind of cartridge of parchment paper containing a central stem of positive metal (zinc), which is held in position by stout cardboard discs at top and bottom, and with the ends projecting that one of them may rest upon the head of the bolt of the cylinder bottom in metallic contact, the other end serving as a hand hold to insert or to withdraw the cartridge from the cylinder. The space between the zinc and the paper is filled with an exciting salt to be moistened as above mentioned, which salt is enclosed in the cartridge.

The projection or link portion of the cap plate has a hole in it for taking over the stem of the bolt of the next adjoining cylinder as an element to form the voltaic connection therewith, the link end being retained loosely thereon by a nut. I fit a washer of hardened rubber upon the cap to retain it in position by a nut, between which and the nut before spoken of the cap link is retained.

A series of cylindrical elements thus made and linked together forms a chain of any given length, the attachments being at one end only; and in order to retain the elements apart and to permit of the flexibility for rolling up the chain without the elements touching each other I pass each cylinder through slits in a proportionately wide tape or band of strong waterproof material, that the middle portions of each alternate cylinder appear upon the same side, that when rolled up the canvas of the next elements keeps them out of contact.

Instead of passing the elements through slits in the canvas I purpose uniting two canvas tapes together at intervals by sewing, and push the unconnected ends of the elements into the loops thus made.

According to another part of my Invention I purpose using a thread braided exterior upon an interior cord for spinning my naked wires upon when forming bands according to my Patent, No. 3519, of the year 1873. The braided exterior or covering to the cord enables me to maintain the flat coils of zinc and copper wire at the respective distances apart without displacing themselves and forming false contacts when they receive the necessary pressure which attaches the wires thereto, or when the bands are rolled up.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Isac Louis Pulvermacher in the Great Seal Patent Office on the 28th March 1877.

Isac Louis Pulvermacher, of 194, Regent Street, in the County of Middlesex, Electrical Engineer, "Improvements in Apparatus or Appliances connected with Generating, Conducting, Measuring, or Testing and Applying Electricity."

Pulvermacher's Impts. in Apparatus for Generating and Applying Electricity.

This Invention relates to improvements in apparatus or appliances connected with generating, conducting, measuring, or testing and applying electricity, and consists in employing carbon vessels of a certain porosity and of various shapes, for instance, flat or cylindrical. In the hollow of these vessels I place a bar or hollow cylinder of zinc in such a manner as to prevent a contact with the carbon vessel. The space between the zinc and the carbon vessel is filled with pulverized sal ammoniac or a substitution thereof of any other salt of an analogous action, which when slightly moistened with water, so as not to dissolve, excites the galvanic element thus formed. When the circle of such an element is closed an electric current of a constant action is produced by the atmospheric oxygen absorbed by the porous carbon vessel. The oxygen in presence of the sal ammoniac depolarises the carbon and thus secures a constant current. Such elements I use for making stationary as well as chain batteries, and I establish voltaic connections among such elements accordingly.

This first part of my Invention will be clearly understood by reference to the annexed Drawings, in which Figure 1 represents a few of my carbon cylinders with other fixtures, by which each serves as an element or part of a battery for the production of electricity to be conducted to any appliance with which it or they may be connected by conducting wires.

a, *a*, are the cylinders, preferably of compressed pure or compounded carbon powder of round or of some other shape, open at both ends. One of these ends to form the bottom is closed in by a wad of gutta percha *b*, moulded and compressed therein to make it a fixture.

The central part of the gutta percha wad has an aperture in it for the passage and reception of the stem *c* of a bolt like pin, the head *d* of which abuts upon the inner surface of the gutta percha wad and without touching the carbon cylinder. The stem *c* projects through and beyond the outside of the gutta percha, and a portion of it is threaded to receive a metallic nut *e*, which presses upon an ebonite washer *f* and clamps the base of an end cap *g* between it and the bottom edge of the cylinder *a*. This base cap has a raised circular edge or flange *h* to embrace the outer edge of the carbon cylinder, and a burring down of the flange fixes it into close holding contact. The stem *c* extends beyond the nut *e*, and an extension or lip *i* of the next adjoining base plate is caused to take over it as shown and be held loosely to it by another nut *j*, so that the lip is so to speak jointed or hinged to it; the series of base plates to any number for any length of elements or chain being thereby linked to each other.

The chamber in each cylinder above the gutta percha wad *b* receives a kind of cartridge composed of a metallic thimble or inverted cup *k*, preferably with parallel side walls, and with the inner periphery of a size to exactly fit the head *d* of the bolt pin, which not only forms the connection of the two metallic bodies, negative and positive, but centralizes the thimble within the carbon cylinder. This thimble *k* is surrounded by an envelope or casing of parchment paper *l*, which reaches beyond the closed end of the thimble for containing the salt for exciting purposes, the salt resting upon the thimble in which a small hole has been previously formed for emptying the vessel of liquid, which accumulates within it from the moisture of the salt, the liquid being chlorate of zinc.

The top end of the parchment paper is closed in to retain the salt, the paper being of such a texture and nature that any moisture supplyed to it finds its way through to damp the salt without permitting the chlorate of zinc or zinc solution to pass through into contact with the carbon cylinder, which would become deteriorated should such happen.

In the Drawing I have shown a few of such cylinders as elements of a battery connected at the bases, and with the bodies pushed into and through slits in a strip of fabric or broad tape *m* (waterproof), the slits being alternately on the same level to obviate tearing it.

In practice I purpose having these slits formed in the weaving of the fabric or tape *m*, they may however be cut, and the cut edges sewn or edged up. Each

cylinder is thus held at a fixed distance apart, as in Figure 2, corresponding to the bases and lips of each pair, to enable the chain of cylinders to be rolled up, and yet kept out of contact with each other by the double thicknesses of the fabric which alone touch. In this view the fabric is double, and a line of sewing is arranged between every two cylinders which are inserted like into open pockets.

Figure 3 represents a few carbon cylinders *a*, in which the bottom edges are not only embraced by the flanges *h* of the bases *g* at the outside, but the inner peripheries are also held by ears or projections *n*, *n*, formed from the inner portion of the bases, which in this plan are like rings with the ears turned upwards for the purpose. The lip *i* of each base in this case is not cut out as in the former one, but has a punched up cup *p*, as in Figures 4 and 5, which finds a lodgment in the aperture of the gutta percha wad, as in Figure 3.

The zinc metal in the preceeding method is of cup or thimble shape, but in this it is a solid stout wire with its lower end projecting through the end of the parchment paper casing.

The chamber of the casing is filled with an exciting salt as before explained, and the projecting end of the zinc wire is forced down the aperture of the gutta percha wad *b*, and bears in actual contact with the punched up cup *p* of the lip of the next adjoining base, whereby the positive metal of one cylinder is in conduction with the negative metal of the next element in voltaic connection.

The lip of each base is curved at the neck *u*, and each gutta percha wad *b* is only half embedded in the bottom end of its cylinder, the other half projecting to distance the lip to permit the cylinders being on a level and to prevent them coming into contact. The elements thus made can be stood upright within a box, either in a line or in zig-zag order for economising space, the bases of each resting upon the bottom of the box to keep the zincs in contact with the lip cups. If they are to be joined and used as a chain, I prefer to employ an extra base and lip upon the opposite end of each cylinder, so that they are connected and linked together, in which case the zinc rods can pass through at each of the ends of the cylinders to engage into or through the lip cups, which may be perforated for the purpose. These cylinders as elements of a battery may be passed into and through slits in a fabric or tape, or annular grooves may be formed for the reception of cords which can be knotted at the junction of every two cylinders. This cord method also applies to the first named cylinders.

According to the second part of my Invention I construct my open ended cylinders of carbon (incrustation of gas retorts), having when brought into a state of paste a proportionate quantity of peroxide of manganese, of chloride of silver, or of chloride of platinum in powder admixed with it. The cylinders have each a groove formed in the inside near one end for the reception and fixation by pressure of the gutta percha wad as before explained.

Figures 6 and 7 represent detached views of my parchment paper containing the zinc rod, and the exciting salt done up as a cartridge. The rod and the salt being held therein by gutta percha, cardboard, or grooved wooden discs at top and bottom, the discs being of such a thickness that the paper can be impressed into the edges when tied round with fine twine or thread to enable the cartridges to be renewed from time to time within the carbon cylinders as occasion requires.

According to the third improvement I form hollow vessels or cylinders of zinc and attach a series of carbon rods within recesses formed in the exterior of the zinc but out of actual contact by threads wound spirally upon them. The whole of the carbon stems are held in the recesses by wires bound round the vessel or cylinder, which wire forms the conducting wire to be connected with the zinc of the next element.

According to the fourth part of my Invention I substitute silver coated with platinum black for the carbon rods or stems referred to in the forgoing.

My fifth improvement consists of a voltameter or electrolytic current measurer combined with a variable resistance changer and measurer and graduator of the strength of the currents.

Pulvermacher's Impts. in Apparatus for Generating and Applying Electricity.

My sixth improvement consists in making a resistance coil for measuring and for testing the strength of an electrical current from bands made of thin German silver wire spun by the process and in the manner adopted by me in making my voltaic bands.

The fifth part is represented in Figures 8 and 9 of the annexed Drawings, consisting of a glass or other insulating material, jar, or vessel A hermetically closed by a stopper B, in or through which a glass tubular stem C is fitted. The upper end of this glass stem is graduated, and near the portion where it enters the stopper an indicating finger D is fitted, so that one can be moved round with the other for the finger to indicate the amount of resistance inserted into the electric circuit, the edge of the band or stopper ring E being graduated for the purpose, and having one of the conducting wires from the battery affixed.

The glass stem tube is continued towards the bottom of the vessel, where it is bent into a circular form, as in the plan view, Figure 9. It has a thin platinum strip or wire as an electrode through its whole length, and with the lower end projecting beyond the end of the glass. The top end of the platinum wire has the other conducting wire of the battery affixed to it by a loose fitting ring which is free to slide round upon the stem when turned in order to prevent a drag being put upon the battery wire. Within the vessel at the bottom part is a separate glass tube F, also bent into circular form. This tube is of larger diameter and of larger tubular area in order that the bent portion of the stem tube may enter into it and thus break up or reduce the thickness of the body of water within it, the vessel A being charged with water to a given height, and free to enter both the stem tube C and what might be termed the bottom or bed tube F, one end of which is closed. The other end of this tube is open, and has one or more platinum wires I attached in ring form, and a conductable wire G to lead the current up to the metallic stopper ring or band E with which the first-named battery wire is affixed.

The water in the vessel is tinted by some colouring matter so that its rising in the glass tubular stem C may be easily seen and be read off as occasions require it.

The electric current in passing into the vessel A causes a decomposition of the water to take place between the platinum wire end H and the platinum wire I, whereby a gas is formed which rises above the water and fills the space above it, the pressure of the gas acting upon the surface of the water and driving it up the glass stem, as before explained, to a height corresponding to the power of the current which indicates the amount of decomposition effected, the water rising being equivalent to the volume of gas produced.

The free end of the bent portion of the glass stem is presented at starting close to the mouth of the bed tube F, whereby the two platinum electrodes which are then almost together meet with a minimum resistance by the water, the index finger of the graduated stopper band being at zero.

The stem tube end can, as before stated, enter the bed tube to the extent of nearly one half the circumference of the vessel, and consequently the platinum electrode of the stem passes the platinum electrode of the bed tube, thereby occupying a large portion of the bed tube chamber by driving the water out of it, leaving only a thin film of water between the outer wall of the stem tube and the inner wall of the bed tube, whereby the degree of resistance is increased in proportion to the distance the wires are apart, the amount of resistance being indicated upon the stopper band graduated scale.

I provide a removable plug J to the stopper to admit of the gas escaping and the apparatus being again made ready for a fresh testing.

Instead of the glass tube being bent at the bottom end, as before explained, it may terminate near to it, and the bent portion be of some non-conducting yet to an extent flexible material, with a thread of india-rubber wound spirally upon the part which enters the glass bed tube, the spirals being at such a distance apart that a spiral column or body of water is formed between the bed tube and the inserted bent piece for the conduction of the current from one platinum wire or electrode to

the other, in a similar manner to that before explained for measuring the resistance within the apparatus.

Figure 10 is a sectional elevation of an automatic compensating galvanometer, which also serves as a measurer and graduater of resistance by the automatic increase or diminishing of resistance in the electrical circuit. In this the hollow stand or box has a slit or groove K in the bottom of it charged with oil, in which the "bob" L at the lower end of an index finger M forming part of a galvanometer needle is caused to move when the index finger is deflected by the power of the current acting upon the magnetized plates forming the magnetic needle hereafter described. The needle is composed of a series of dished plates N, N, of steel (magnetized), the convex portions of the dished ones being arranged opposite or backed to each other with an intermediate flat steel disc P between them. The whole is held together by a vertical rod M by screw nuts top and bottom, and they carry a transverse axis Q by which they are supported and suspended with very little frictional touch in sockets R of arms carried down the stand in the inside from a top edge ring S.

The edges of the dished plates and of the intermediate one are fastened to a segmental metallic band T which forms an exterior covering like a hood, from the bottom edge of one lower plate over in circular form to the lower edge of the same plate on the opposite side, the point of the index finger M passing through its centre at top.

The index finger works over a graduated arc U for indicating the amount of the deflection. The conducting wires of the battery are connected with metallic cups V, V, in the bottom of the vessel or stand A, the cups having small metallic spheres W, W, falling loosely within them for conducting the current through fine metallized threads X, X, and tinned leaden clips to a strip of conductable paper Y which is temporarily placed over the hood of the needle.

The strip of conductable paper, a sample of which is shown at Figure 11, with the tinned lead clips Z, the fine metallized threads X, X, and the spheres W, W, attached is blackleaded in zig-zag or or in unbroken divisions in any manner for furnishing the resistance to be inserted into the circuit.

When the paper is upon the hood the clips hang down and serve as weights to take the paper ends from contact with the hood when the needle is turned. The hanging of the needle in the manner described facilitates its removal for the detachment of the used up strip of paper, and for the placing of a fresh one when desired to change the resistances.

Different resistances are obtained by blackleading the paper on the whole of its surface or by using some conductable metallic powder painted or printed on as a substitute for blacklead. The spheres W, W, at the end of the paper threads X, X, rest in metallic lined cupped recesses V, V^1, in the bottom of the stand A, and one of them is in connection with one wire a^1 of the battery, the current passing through the apparatus to the inside top layer of a covered wire coiled upon the outside of the stand, the current passing through the coil to the outside bottom layer, whence it passes to the other battery wire a^{11} as indicated.

The "bob" moving in the oil prevents vibration of the index finger when moved over. A plan of the needle and vessel is shown at Figure 12, and of the vessel with the needle removed at Figure 13. The action of this apparatus is as follows:—The current enters by the wire a^1 and along the thread X by the sphere W to the tinned clip Z to the hood T passing through it to the opposite side to the clip Z^1, thread X^1, sphere W^1, metal cup Y^1, to the wire b^1, to the coil at the upper part, so as to pass through the entire coil and come out at the lower portion or end to the other battery wire a^{11}. The current in the coil causes a movement of the needle and a deflection of the index finger in proportion to the degree of the strength of the current.

As the needle turns upon its axis one end of the paper strip is lowered and compels the current to travel through the blackleaded surface of the paper which is away from the hood, thereby offering a resistance to the current in proportion to

the quantity of the paper unwound from the hood. If the power becomes inconstant or weakened the index finger is inclined to go back to zero, but in that case the resistance diminishes and the strength of the current is balanced and compensated.

The above description applies to the deflection of the index finger over either side of the graduated arc. If in the same circle an additional outer resistance is inserted such as when the electrodes are applied to the human body, the outer resistance thus added will be compensated by the diminished resistance in the instrument, through the papers being again taken on to the hood. When the paper strip is removed and a connection of the wire a^1 made with the inner layer at the top of the coil, the instrument is converted into an ordinary galvanometer.

Figure 14 represents one of my improved voltaic bands of naked wire elements upon edge cords *r*, *r*, over which cords as ordinary twisted cords or as braided cords other threads *s*, *s*, have been braided thereon for forming a smooth surface upon the exterior. These braided edge cords are important for the uniform distribution and lodgment of the wires forming my hollow bands, and prevent the tendency of the wires to slipping down the twists of the ordinary twisted cords previously used by me, by which the wires came into contact if not insulated or separated by other appliances. This Figure also represents in a hollow band a fitting in of an absorbent material of an exciting liquid of short straws or fine reeds *t*, *t*, which are capable of being impregnated with a concentrated solution of an exciting salt without becoming rigid; said straws or reeds are connected side by side by threads *u*, *u*, near the ends. The straw lining is made in lengths and as the wire band is made the lining is enclosed or worked in by the wire spinning mechanism to take a position within each element for the full length of the band. The lining straws or reeds are made in lengths of much greater width than that required for use in the chain or band by weaving a couple or more of threads as warp threads being used for interlacing the straws at the respective distance apart, so that when the weaving is completed the straws as a web are cut into strips with two rows of threads to each, the width of the cut corresponding to the width of the hollows of the band in which the strip has to be fitted or lodged.

Where the divisions of the elements occur I draw or otherwise remove one of the straws or reeds from that part, and this not only improves the flexibility of the band, but prevents false contacts of any two elements by keeping separate the liquid from between one element and another.

Bands made with the straw or reed lining remain supple even after being saturated with oxide of zinc, which is not the case with bands having a felt or flannel lining as in my previous Patents.

In the application of my naked wire bands direct upon the body, the action of the current has produced irritations of the skin.

Now according to a further improvement and to prevent the inconveniences named above, I fit a piece of felt *v* or like fibrous body on one face of the band or chain, which felt when moistened with vinegar or other exciting liquid has the effect of conveying the current by wet conduction for the full length of the band or chain. By wetting the end felt pieces of the series only a dry application of a polar current is obtained, in which case the wire band is wetted in addition to the end felts, but not the intermediate felt pieces. This outside felting of the wire band or plate chain is applicable to my spirally thread coated wires, and the application or fixation of the felt is effected by looping the ends of the felt under one of the wire coils at each end of the element, and drawing the ends tight, as is shown in Figures 15 and 16 of the Drawings.

In forming my hollow bands of naked wires within which the straw or reed web is inserted as before explained, I form a groove along the central line on one side of the band, and I attach a series of insulated buttons with shanks upon the other side of the band as in Figure 17, so that when the band is rolled up the buttons find a lodgment in the groove, and insulate each coil from the next, as in Figure 18, and

prevent the coil slipping from the roll when the roll is surrounded by an annular fastening of insulating material.

The application of the buttons and the formation of the groove are not limited to the naked wire bands only, as they are equally applicable to my spiral thread coated wire bands whether the straws or reed web be used as a lining or not.

Having now described the nature of my said Invention and in what manner the same is to be performed, I declare that,—

Firstly. I claim the combination of a compressed carbon (incrustations of gas retorts) open ended vessel with end gutta percha wad, and with a zinc vessel in the interior enclosed with an exciting salt in a casing or envelope of parchment paper, as and for the purpose set forth and substantially as shown at Figure 1 in the annexed Drawings.

Secondly. I claim the making and employment of cartridges as separate articles containing solid or hollow zinc, and an exciting salt for insertion into carbon vessels, as and for the purposes set forth and substantially as shown in Figures 1, 2, 3, 6, and 7 of the annexed Drawings.

Thirdly. I claim the combination of carbon cylinders or vessels with enclosed cartridges all arranged in voltaic conduction as a chain or band as set forth, and substantially as shown in Figures 1 and 2 of the annexed Drawings.

Fourthly. I claim the use of metallic bases with raised flanges for carbon cylinder vessels, said bases having lips or extensions for connecting with the stems of studs projecting from adjoining carbon cylinder vessels, as and for the purpose set forth and substantially as shown in the annexed Drawings.

Fifthly. I claim constructing cylinder vessels of carbon, peroxide of manganese, or peroxide of iron and chloride of silver, or in lieu thereof chloride of platinum, in combination by compression as described under the second head of this Specification, and the employment of said compounded cylinder vessels for the purpose set forth.

Sixthly. I claim constructing zinc cylinder vessels with recesses and fixing thread coated carbon stems in said recesses that a portion of each of them project beyond the exterior of the cylinder to enable them to be retained and united in the recesses by an annular conducting wire, as and for the purposes set forth under the third head of this Specification.

Seventhly. I claim the employment of silver coated with platinum black in recesses of zinc cylinder vessels as a substitute for the carbon rods above mentioned, as and for the purpose described.

Eighthly. I claim the employment of thin German silver wire or alloy silver and platinum wire spun in band form analogous to my voltaic bands as a substitute for the ordinary resistance coil used for measuring and graduating resistances in a circuit.

Ninthly. I claim the electrolytical current measurer and graduator shown at Figures 8 and 9 of the annexed Drawings, especially the employment of a movable glass tubular rod, and of a fixed glass tube to which platinum are affixed as set forth, the whole acting as and for the purposes described.

Tenthly. I claim the automatic resistance compensating galvanometer shown at Figure 10 of the annexed Drawings, acting as and for the purposes set forth, especially the formation or arrangement of the magnetic needle and the suspension of same as described.

Eleventhly. I claim the employment of detachable strips of paper prepared so as to render the surface conductible with more or less resistance to a current.

Twelfthly. I claim the employment of cords whose surface is rendered smooth and uniform by a braided exterior as edge cords in wire elements, as and for the purpose set forth, and substantially as shown at Figure 14 of the annexed Drawings.

Thirteenthly. I claim the employment of web or strips of straw or reeds as exciting liquid holding medium within hollow bands used for the purposes described,

said straws or reeds being held by threads as set forth, and substantially as shown in the accompanying Drawings.

Fourteenthly. I claim the application of shanked buttons of insulating material in or to the central line on one side of a hollow band, said buttons taking into a central groove formed in the other side of the same band when the band is rolled up, the buttons keeping the coils of the band apart without slipping out and ensuring the insulation of one coil from another when charged with an excitant.

In witness whereof, I, the said Isac Louis Pulvermacher, have hereunto set my hand and seal, this Twenty-eighth day of March, One thousand eight hundred and seventy-seven.

I. L. PULVERMACHER. (L.S.)

LONDON: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty. 1877.

Fig. 1.

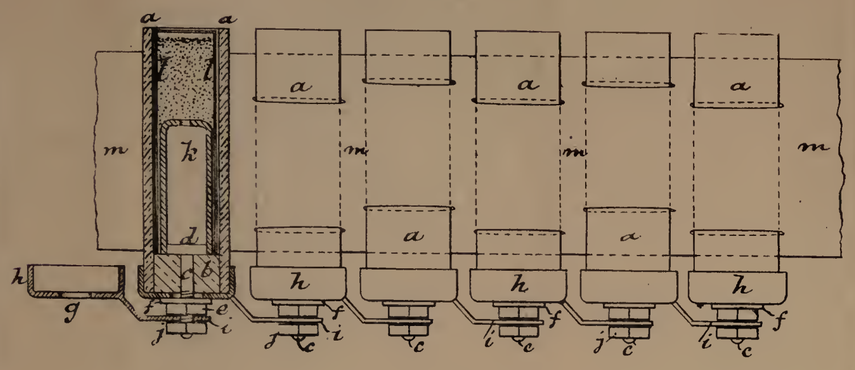


Fig. 2

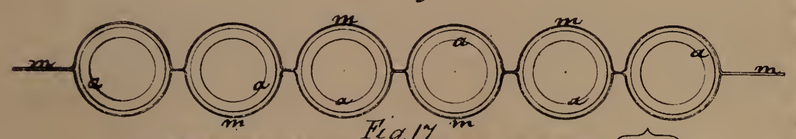


Fig. 17

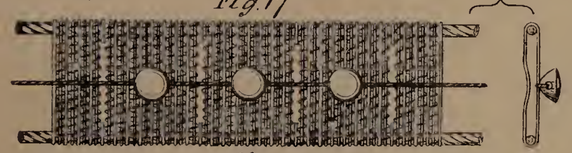


Fig. 8

Fig. 9

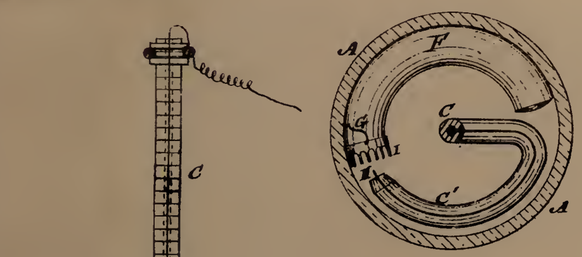


Fig. 18.

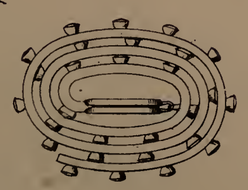


Fig. 3

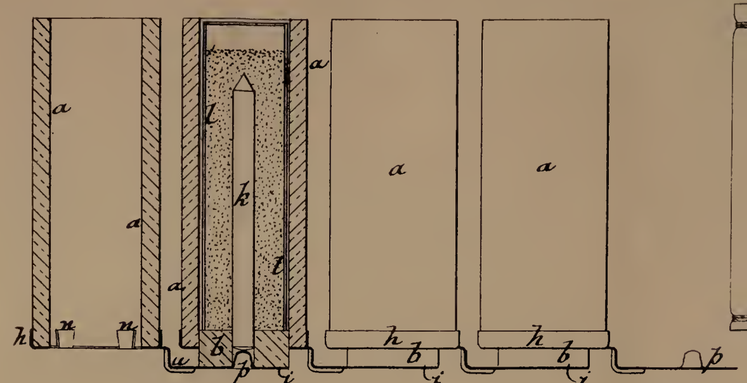


Fig. 4

Fig. 6

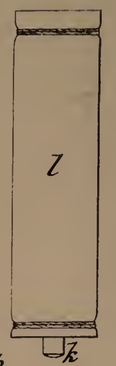


Fig. 7

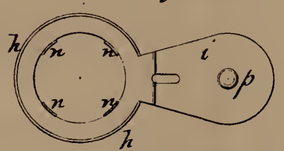


Fig. 5

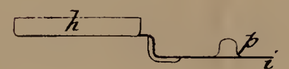


Fig. 14

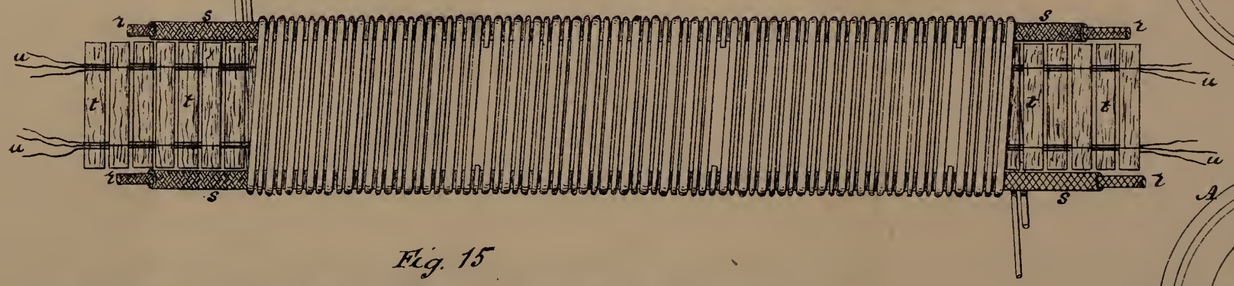


Fig. 15

Fig. 16

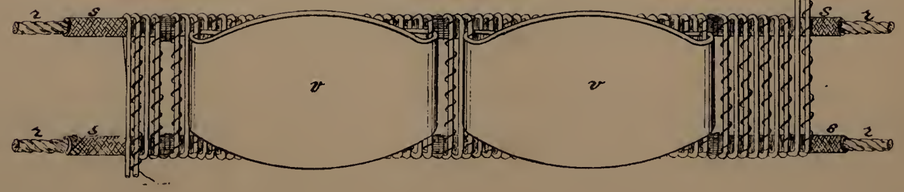


Fig. 10

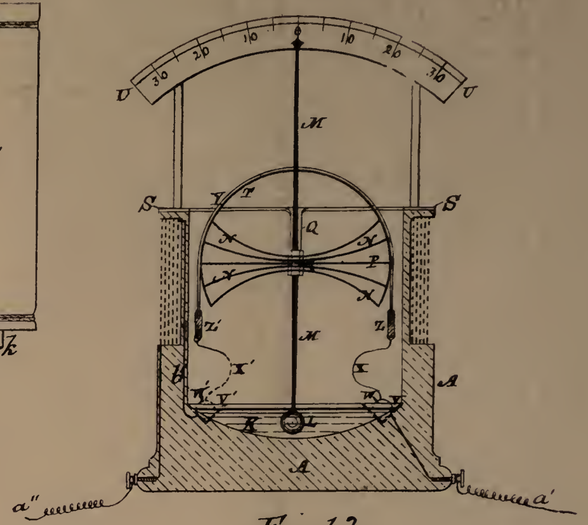


Fig. 12

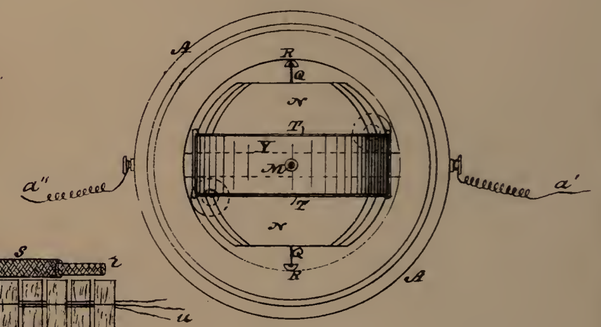


Fig. 13

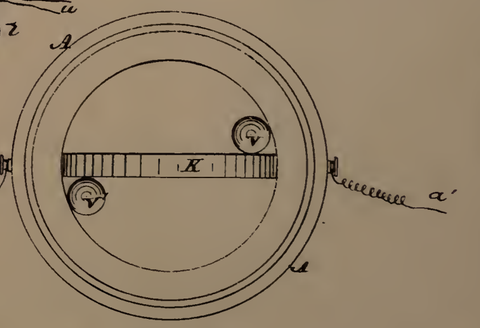
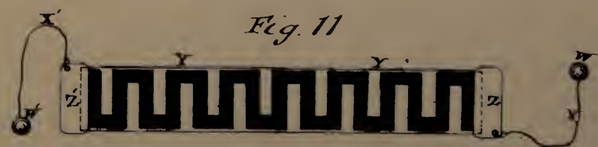


Fig. 11



The filed drawing is not colored

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Printers to the Queen's most Excellent Majesty. 1876.

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